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THE OCCURRENCE AND ORIGIN OF AMBER IN THE EASTERN UNITED STATES.[1]

ARTHUR HOLLICK.

A Recent Discovery of Amber in the Cretaceous Deposits at Kreischerville, N. Y.

Preliminary Note.— A recent discovery of amber in considerable quantity, in connection with the Cretaceous deposits at Kreischerville, Staten Island, N. Y., may be found briefly recorded by the writer in the *Proceedings* of the Natural Science Association of Staten Island for November 12th, 1904, but without any extended description or discussion. The discovery, however, was found to have aroused an unexpected interest in the subject, and the preparation of this paper was suggested.

Geologic Age and General Description of the Deposits.—The deposits in question consist of clays and sands which represent a part of the eastward extension of the Amboy clay series of New Jersey and are included in the Raritan formation, which is generally recognized as middle Cretaceous in age and approximately the equivalent of the Cenomanian of Europe, the lower Atane beds of Greenland, and the Dakota group of the West.

At Kreischerville they have been extensively excavated for economic purposes and in what is known as the Androvette pit a section was recently exposed, consisting of irregularly bedded clays and sands, referable to the geologic horizon above mentioned, overlain unconformably by more recent sands and gravels, the entire series showing more or less disturbance by glacial action. A view of a portion of the pit is shown in Plate 1.

Conditions Under Which the Amber Occurs.— The amber occurs in a stratum or bed, characterized by layers and closely packed masses of vegetable débris, consisting of leaves, twigs,

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[1] Read before the Botanical Society of America, Philadelphia meeting, Dec. 30, 1904. Investigations prosecuted with the aid of a grant from the Society.

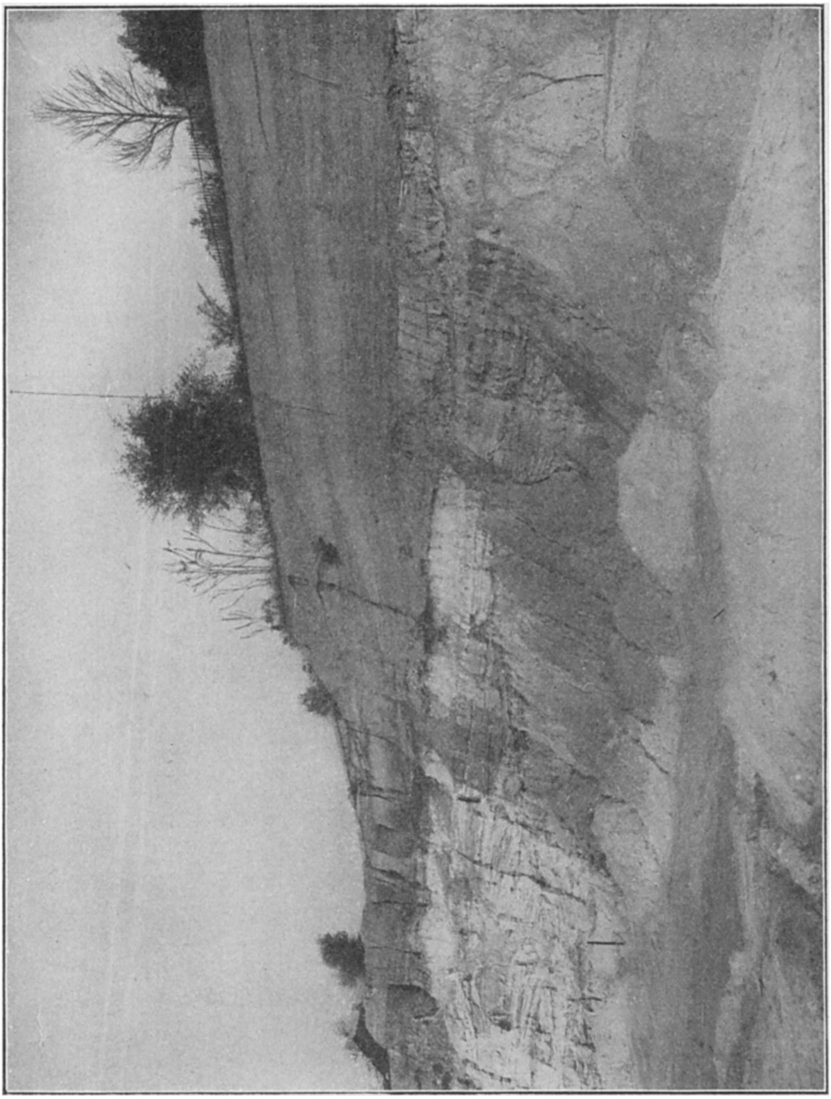

PLATE 1.—Section in Androvette pit, Kreischerville, Staten Island, N. Y., showing unconformity between Cretaceous clays and sands below and Tertiary or Pleistocene sands and gravels above.

and fragments of lignite and charred wood. Pyrite, in nodules, is also a prominent constituent. This bed, where exposed in vertical section, appears as if lens-shaped, having an indicated maximum thickness of about 3 feet and a lateral extent of 18 feet or more. The face of the pit at this place is about 20 feet high. and the lower part of the bed is about 1 foot from the present floor of the pit. The section in which the bed is exposed is shown in Plate 2. It is immediately adjacent to the left of the section shown in Plate 1.

Most of the amber was found in a relatively thick accumulation of finely comminuted lignite and charred wood, of limited extent, through which it was irregularly distributed. This matrix yielded nearly all of the larger specimens and a majority of the smaller ones. The remainder were obtained from the relatively thinner layers of leaves and twigs. A piece of the lignitic matrix, with fragments of amber enclosed, is shown on Plate 3, Fig. 34.

Characters of the Amber.— A large part of the amber is in the form of drops or "tears," examples of which may be seen on Plate 3, Figs. 1–23, but irregularly shaped fragments, varying in size from a large pin's head to a hickory nut, are the most abundant. They are generally more or less transparent and yellow or reddish in color, but many are opaque and grayish white. Some of the best examples of the former are shown on Plate 3, Figs. 24–32, and a large piece of the latter on Plate 3, Fig. 33. The finest specimen in size, color, and transparency, represented by Fig. 32, is about 6 cu. cm. in volume. All of the figures on Plate 3 are of natural size.

Disposition of the Specimens.— Most of the specimens collected are deposited in the museum of the New York Botanical Garden and the remainder in that of the Natural Science Association of Staten Island. The only other specimens from this vicinity which I have been able to locate are included in the collections at Columbia University. These are three in number and are labeled respectively, "Marl pits, Squankum, N. J.," "Kirby's marl pit, Harrisonville, N. J.," and "Valentine's clay pit, Woodbridge, N. J." The last mentioned is of good quality and is about the size of a filbert nut.

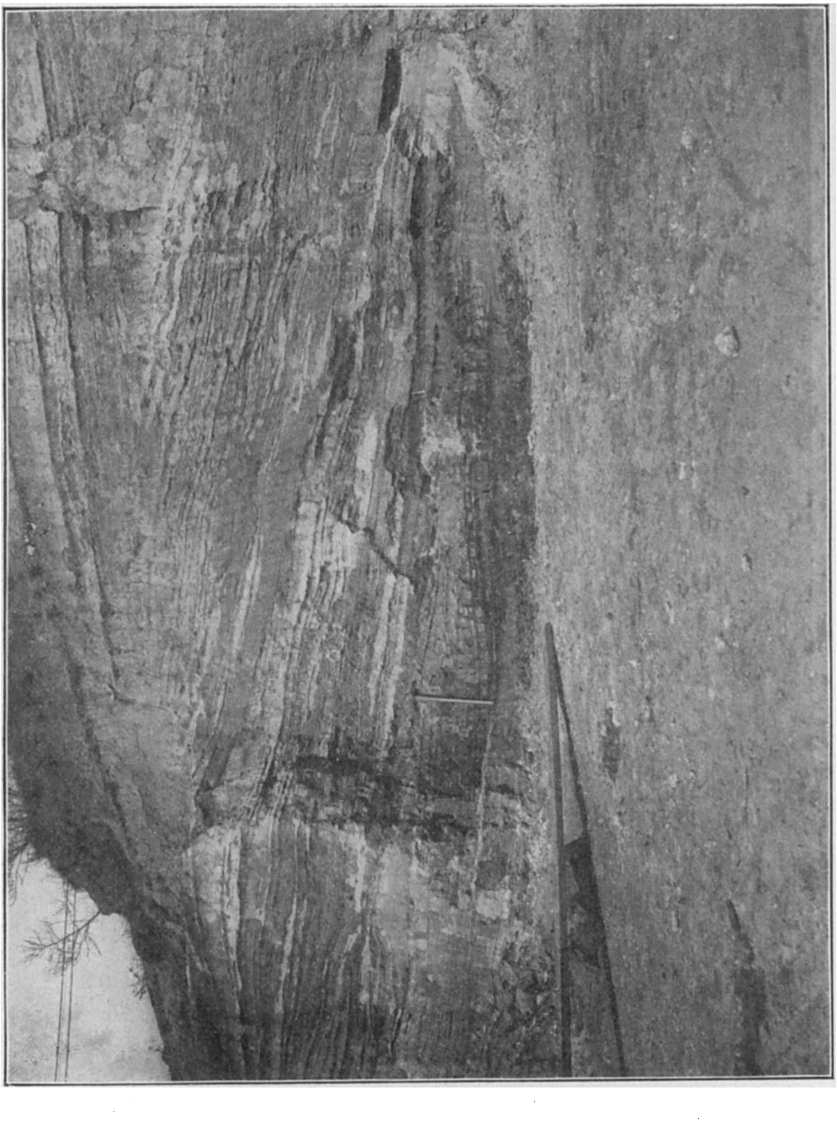

PLATE 2.—Section in Androvette pit, Kreischerville, Staten Island, N. Y., at extreme left of Plate 1, showing stratification of the Cretaceous deposits and bed, indicated by the pick, in which leaves and amber occur.

PREVIOUS RECORDS OF THE OCCURRENCE OF AMBER IN THE EASTERN UNITED STATES.

It is probable that amber is far more common in the Cretaceous deposits of the eastern United States than is generally supposed. The amount that may be obtained at the Kreischerville locality alone is considerable, as evidenced by the relatively large quantity that was obtained in the few hours devoted to the work, from the small portion of the exposure examined; and reports of its occurrence elsewhere indicate that careful search, with amber as the object in view, would produce excellent results.

Probably the earliest published record on the subject is contained in an article by G. Troost, entitled: "Description of a Variety of Amber and of a Fossil Substance supposed to be the Nest of an Insect, discovered at Cape Sable, Magothy River, Anne Arundel County, Maryland" (*Am. Journ. Sci.*, vol. 3, 1821, pp. 8–15), in which he describes the amber as occurring with lignite, and says (p. 9): "This lignite seems to be formed of three varieties of wood, or rather the wood has undergone three different changes, some pieces of which are entirely charred, often changed into bituminous wood, and others again having undergone very little change from the brown lignite. All these varieties, particularly the brown lignite and the charred wood, are penetrated by pyrites, and are sometimes entirely changed into it."

The above account is of considerable interest to us for the reason that the geologic horizon in which the amber was found at Cape Sable is approximately the equivalent of that at Kreischerville, and the conditions under which it occurs at both places are evidently identical. The meaning or significance of the charred wood presents an interesting problem, as it apparently indicates the direct effect of fire, at or immediately prior to the time when the deposits were laid down, and not that of any chemical change such as resulted in the gradual transformation of the wood into lignite. Further than this, its occurrence in such widely separated localities indicates that whatever the source of the heat may have been, the effects were far-reaching and extended over a considerable area. The same author, in the

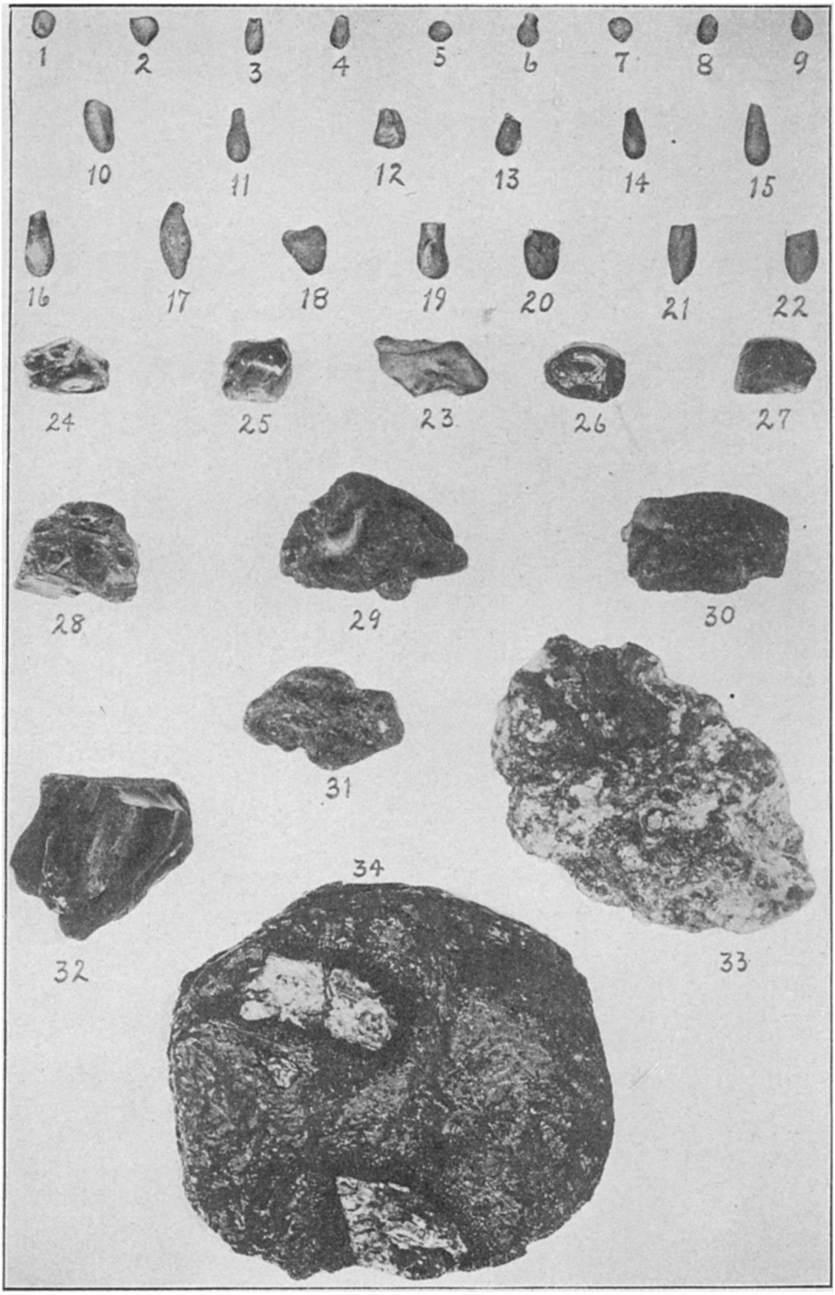

PLATE 3.

Figs. 1–23. Amber drops or "tears," Kreischerville, Staten Island, N. Y.
Figs. 24–33. Amber masses and fragments, Kreischerville, Staten Island, N. Y.
Fig. 34. Matrix containing amber, Kreischerville, Staten Island, N. Y.
(Figures are all natural size.)

article above quoted, also indulges in speculations concerning the kind of wood from which the amber was probably derived, and says (p. 13): "But I have not been able to ascertain the species to which it belongs."

Apparently nothing further was recorded in regard to the subject until 1830, when S. G. Morton published a paper entitled: "Synopsis of the Organic Remains of the Ferruginous Sand Formation of the United States, with Geological Remarks" (*Am. Journ. Sci.*, vol. 17, 1830, pp. 274–295) in which he mentions (p. 293) "vast deposits of lignite with amber," in the sections exposed in cuttings made for the Delaware and Chesapeake canal. Incidental reference to the above may also be found in a subsequent article "On the Analogy which exists between the Marl of New Jersey and the Chalk Formation of Europe" (*Ibid.*, vol. 22, 1832, pp. 90–95).

After this, for a period of some fifty years, our native amber apparently attracted but little attention, or at least there does not seem to have been anything additional recorded in regard to it during that time. A popular article, by Mrs. Erminnie A. Smith, entitled "Concerning Amber," was published in the *American Naturalist*, for March, 1880, in which the only reference in this connection is the following brief paragraph (p. 187): "Very little amber has as yet been found in the United States. Gay Head, Martha's Vineyard, Camden, N. J., and Cape Sable, Md., only are mentioned as its localities. A barrel full of small pieces was taken out of the greensand in New Jersey, which through some mistake was burned."

At a meeting of the New York Academy of Sciences, on February 5th, 1883, Mr. Geo. F. Kunz exhibited a mass of amber $\frac{3}{4}$ lb. in weight, which was said to have come from the Tertiary deposits of Nantucket, and read a paper "On a large Mass of Cretaceous Amber from Gloucester County, New Jersey," in which was described a mass weighing 64 oz., found in Kirby's marl pit, near Harrisonville (*Trans. N. Y. Acad. Sci.*, vol. 2, 1883, pp. 85–86). In the subsequent discussion of this paper Dr. J. S. Newberry is quoted as remarking that "in one pit [in Gloucester Co.] a whole barrel full had been found and burned by the workmen"; which remark probably has reference to the incident mentioned in Mrs. Smith's article. In the record of this discussion may also be found a statement, credited to Mr. W. E. Hidden, to the effect that amber had been discovered during the previous summer in the marl beds of North Carolina, and a hearsay reference to a very large specimen from New Jersey, which was "found on the shore of Raritan Bay, and now deposited in the museum at Berlin, Germany."

In 1885 were made the first discoveries of fossil plant remains in the Kreischerville clays (*Proc.* Nat. Sci. Assn. Staten Isld., Dec. 12th, 1885). These were subsequently described by the writer (*Ibid.*, Feb. 13th, 1886) and at the end of the descriptions may be found the following brief paragraph: "There are also little masses of a yellow substance which I take to be a fossil gum or amber." Mr. Wm. T. Davis also found it there subsequently, according to the following record: "Mr. Davis presented unusually fine specimens of lignite, apparently coniferous, from the clay beds of Kreischerville. The specimens were of the appearance and consistency of jet and contained considerable amber," (*Ibid.*, March 12th, 1892). The above mentioned material from Kreischerville was all found in the immediate vicinity of the deposits recently exposed and probably from parts of the same bed.

PROBABLE ORIGIN OF THE AMBER.

In 1894 the Cape Sable locality was visited by Mr. A. Bibbins, who succeeded in finding and collecting a number of specimens of amber, some of which were included in the interstices of a log of lignite and were evidently derived from it. This lignite was examined by Dr. F. H. Knowlton, by whom it was identified as a new species of Cupressinoxylon (*C. bibbinsi*), or in other words the fossil wood of a Sequoia ("American Amber-producing Tree," F. H. Knowlton, *Science*, vol. 3, 1896, pp. 582–584, figs. 1-4). This identification is important for the reason that it gives us definite information, for the first time, in regard to the origin of at least a portion of the amber in this part of the United States, and suggests a probable source for some of that at Kreischerville, where it occurs in close connection with the leafy twigs of *Sequoia heterophylla* Vel., and *S. reichenbachi* (Gein.) Heer. It may also be of interest to note that leaves of Sequoia are said to be associated with the amber of Japan.

Other coniferous remains which have been found in the Kreischerville clays, and which may have contributed to our supply of amber, are *Widdringtonites reichii* (Ett.) Heer., *Juniperus hypnoides* Heer, *Dammara microlepis* Heer., and Pinus sp. The genus Dammara is prominently represented in our living flora by *D. australis* Lamb, the well known "Kauri" gum tree of Australia. Its former existence, however, as an element in the Cretaceous flora of North America, is somewhat problematic, and is based entirely upon the presence of certain small cone scales, the exact botanical affinities of which have never been satisfactorily determined. The occurrence of remains of the genus Pinus is more significant perhaps than any of the other three last mentioned, by reason of the fact that the typical amber of the Baltic provinces in Europe is recognized as a product of the extinct Tertiary species, *P. succinifera* (Goepp.) Conw.

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